August 27, 2013

ARUP

Re: Standard Penetration Energy Measurements
Automatic Hammer on Mud Rotary Drill Rig, D-44
High Speed Train, Fresno, CA

Dear Sir,

This report offers results of energy measurements and related calculations made on August 22, 2013 during Standard Penetration Testing (SPT) on Gregg Drilling's mud rotary drill rig. Dynamic tests were performed on an instrumented section of NWJ drill rod attached to the sampler rod string. All dynamic measurements were obtained and recorded using a Pile Driving Analyzer®.

Equipment:

SPT energy measurements were made on SPT and Modified California samplers driven by the hammer/anvil system on the Gregg Drilling drill rig on August 22, 2013. The rig was tested on the High Speed Train Project area in Fresno, CA. In total, 6 energy measurements were collected corresponding to 6 different samples at increasing depth.

Gregg used a Model PAK Pile Driving Analyzer (PDA) to acquire and process measurements of force and velocity with every impact of the automatic hammer on the sample rods. Gregg follows the procedure outlined in ASTM D4633. Two strain gauges mounted on a two foot section of NWJ rod measured force, while two piezoresistive accelerometers bolted on the same rod measured acceleration. The gauges were mounted approximately 6" from the top of the rod.
Analog signals from the gauges and accelerometers were collected, digitized, displayed in real-time, and stored by the PDA. Selected output from the PDA for each recorded impact of the hammer included:

- Maximum force in the rod (FMX)
- Maximum velocity in the rod (VMX)
- Maximum calculated transferred energy (EMX)
- Blows per minute (BPM)
- Energy transferred to the rods (ETR)

Data and Calculations:

The purpose of testing was to measure the energy transferred from the hammer to the drill rod and to calculate the energy efficiency of the hammer. The PDA measurements of force and velocity were reviewed after field testing and analyzed to calculate the transferred energy (EMX).

The maximum energy transferred past the gauge location, EMX, is computed by the PDA using force (F) and velocity (V) records as follows:

$$EMX = \int_a^b F(t)\, V(t)\, dt$$

The time "a" corresponds to the start of the record when the energy transfer begins and "b" is the time at which energy transferred to the rod reaches a maximum value. The energy transferred is defined as ETR, and is usually used to define the efficiency of the hammer/anvil system.

Results:

Table 1 summarizes the average calculated energies for each sample tested as well as the type of sample and depth. It is shown that the overall average (ETR) energy for this system is 85%. Appendix A provides plots and tables of PDA results for all hammer blows at each sampling depth. The plots and tables present selected measured and calculated results as a function of blow number. The results include:

- the blow number
- depth
- BLC (blow count in blows per foot)
- FMX (maximum rod force)
- VMX (maximum rod velocity)
- EMX (maximum transferred energy)
- BPM (blows per minute)
- ETR (energy transferred in percent of maximum)

At the end of each table is a statistical evaluation of the results for each variable including the average, standard deviation, maximum, and what blow number this maximum occurred.

If you have any questions or comments on this report, please do not hesitate to call our office at (562) 427-6899.

Sincerely,

Peter Robertson
Technical Advisor
Gregg Drilling & Testing

GREGG DRILLING

SPT ENERGY ANALYSIS

Client: ARUP
Project: High Speed Train
Date: 8/22/2013
Boring: S-0021R
Rig: D44

Table 1 - SPT Sample Summary

Sample #	Sampler	Length of Sample Rod (ft)	Sampler Length (ft)	Total Rod Length* (ft)	Depth of Sample (below Mudline) (ft)	Total Blows Analyzed by PDA	Average Energy Transferred to Rods (% of Theoretical Max.)	Maximum Efficiency Recorded (%)	Standard Deviation
1	Mod. Cal	26	4.58	30.6	25	32	82.6	88.2	2
2	SPT	31	4.75	35.8	30	23	86.6	91.9	3
3	Mod. Cal	36	4.58	40.6	35	44	87.9	92.1	2
4	SPT	41	4.75	45.8	40	59	86.9	93.5	2
5	Mod. Cal	46	4.58	50.6	45	103	84.7	92.2	3
6	SPT	51	4.75	55.8	50	70	83.3	87.8	2
						Average	85.3		

* Total rod length includes, sampler, rod, adaptors, and instrumented section below gauges

Appendix A

D44 - S-0021R @ 25ft
OP: MSULLIVAN

140LB AUTO HAMMER
Test date: 20-Aug-2013

AR: 1.45 in^2
LE: 30.58 ft
WS: 16,807.9 f/s

SP: 0.492 k/ft3
EM: 30,000 ksi
JC: 0.35

EFV: Energy of FV
BPM: Blows per Minute
EMX: Max Transferred Energy

VMX: Maximum Velocity
ETR: Energy Transfer Ratio

BL#	depth	EFV	BPM	EMX	VMX	ETR
	ft	k-ft	**	k-ft	f/s	(%)
1	0.00	0.3	0.0	0.3	12.6	78.4
2	0.00	0.3	0.0	0.3	12.5	80.3
3	0.00	0.3	48.6	0.3	11.9	88.2
4	0.00	0.3	48.7	0.3	11.7	84.5
5	0.00	0.3	48.5	0.3	11.7	83.2
6	0.00	0.3	48.2	0.3	11.7	83.9
7	0.00	0.3	48.5	0.3	11.3	81.1
8	0.00	0.3	49.0	0.3	11.6	83.5
9	0.00	0.3	48.2	0.3	11.4	82.9
10	0.00	0.3	48.7	0.3	11.3	81.9
11	0.00	0.3	48.5	0.3	11.0	81.9
12	0.00	0.3	48.5	0.3	11.0	82.4
13	0.00	0.3	48.6	0.3	11.1	82.2
14	0.00	0.3	48.5	0.3	10.7	81.4
15	0.00	0.3	48.3	0.3	11.3	82.7
16	0.00	0.3	48.7	0.3	11.5	84.9
17	0.00	0.3	48.7	0.3	11.2	82.4
18	0.00	0.3	48.7	0.3	11.3	82.5
19	0.00	0.3	48.6	0.3	11.4	83.9
20	0.00	0.3	48.6	0.3	11.5	85.9
21	0.00	0.3	48.6	0.3	11.3	83.5
22	0.00	0.3	48.7	0.3	11.0	81.8
23	0.00	0.3	48.6	0.3	10.8	85.7
24	0.00	0.3	49.0	0.3	11.4	86.1
25	0.00	0.3	47.9	0.3	10.9	82.3
26	0.00	0.3	48.2	0.3	10.4	82.4
27	0.00	0.3	48.7	0.3	10.4	80.7
28	0.00	0.3	49.1	0.3	10.1	79.2
29	0.00	0.3	48.5	0.3	11.0	83.1
30	0.00	0.3	49.2	0.3	10.2	79.1
31	0.00	0.3	48.8	0.3	10.8	81.7
32	0.00	0.3	49.2	0.3	10.2	79.9
	Average	0.3	48.6	0.3	11.2	82.6
	Std. Dev.	0.0	0.3	0.0	0.6	2.1
	Maximum	0.3	49.2	0.3	12.6	88.2
	@ Blow#	3	32	3	1	3

Total number of blows analyzed: 32

Time Summary

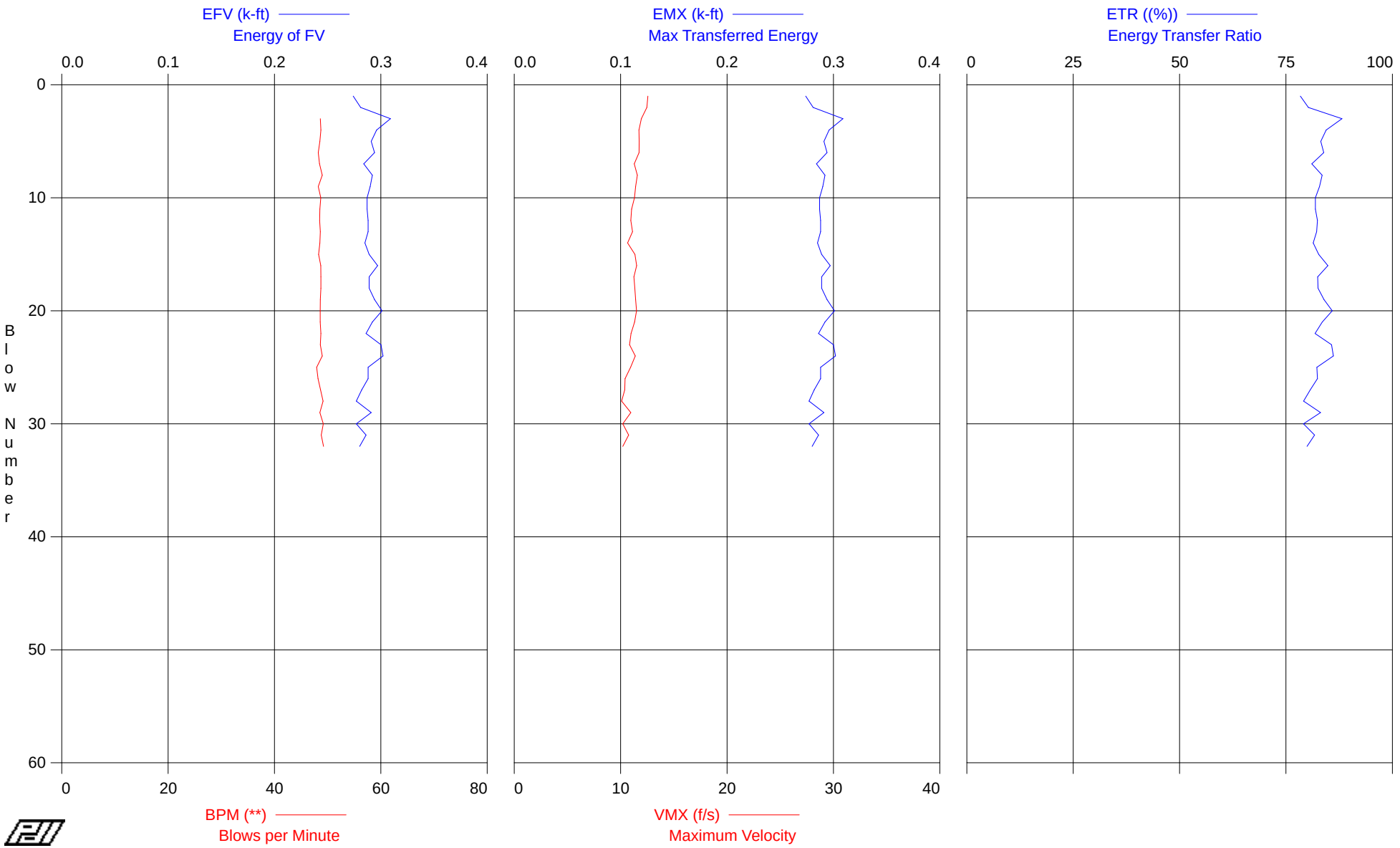
Drive 41 seconds 12:00:04 PM - 12:00:45 PM (8/20/2013) BN 1 - 32

Gregg Drilling & Testing - Case Method & iCAP® Results

PDIPLOT Ver. 2012.2 - Printed: 27-Aug-2013

Test date: 20-Aug-2013

D44 - S-0021R @ 25ft



D44 - S-0021R @ 30ft
OP: MSULLIVAN

140LB AUTO HAMMER
Test date: 20-Aug-2013

AR: 1.45 in^2
LE: 35.75 ft
WS: 16,807.9 f/s

SP: 0.492 k/ft3
EM: 30,000 ksi
JC: 0.35

EFV: Energy of FV
BPM: Blows per Minute
EMX: Max Transferred Energy

VMX: Maximum Velocity
ETR: Energy Transfer Ratio

BL#	depth	EFV	BPM	EMX	VMX	ETR
	ft	k-ft	**	k-ft	f/s	(%)
1	0.00	0.3	0.0	0.3	13.2	81.2
2	0.00	0.3	0.0	0.3	13.4	87.4
3	0.00	0.3	49.3	0.3	13.2	89.3
4	0.00	0.3	49.6	0.3	13.6	91.9
5	0.00	0.3	49.4	0.3	13.3	88.6
6	0.00	0.3	50.9	0.3	12.5	82.1
7	0.00	0.3	46.9	0.3	13.0	89.4
8	0.00	0.3	49.3	0.3	12.7	87.8
9	0.00	0.3	49.8	0.3	12.4	87.5
10	0.00	0.3	49.4	0.3	12.7	89.2
11	0.00	0.3	49.4	0.3	12.7	85.8
12	0.00	0.3	49.4	0.3	12.1	83.8
13	0.00	0.3	49.3	0.3	12.8	87.4
14	0.00	0.3	49.1	0.3	12.7	84.0
15	0.00	0.3	50.5	0.3	12.9	86.9
16	0.00	0.3	48.8	0.3	12.6	84.3
17	0.00	0.3	50.1	0.3	12.9	87.1
18	0.00	0.3	49.8	0.3	12.6	85.1
19	0.00	0.3	49.6	0.3	13.0	89.6
20	0.00	0.3	49.9	0.3	12.3	84.3
21	0.00	0.3	48.7	0.3	12.7	87.5
22	0.00	0.3	49.5	0.3	12.3	85.1
23	0.00	0.3	49.2	0.3	12.9	87.1
	Average	0.3	49.4	0.3	12.8	86.6
	Std. Dev.	0.0	0.7	0.0	0.4	2.5
	Maximum	0.3	50.9	0.3	13.6	91.9
	@ Blow#	4	6	4	4	4

Total number of blows analyzed: 23

Time Summary

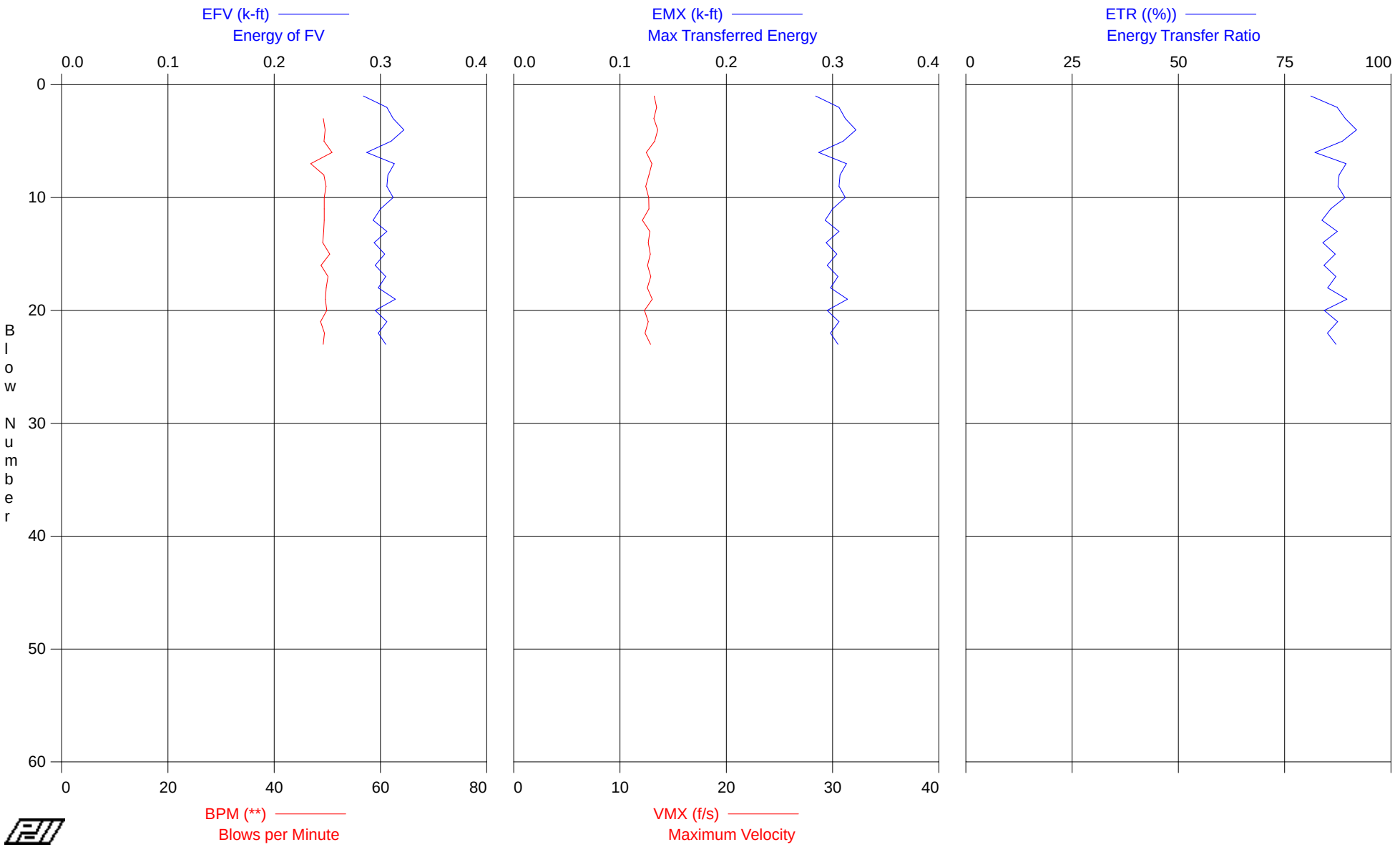
Drive 30 seconds 12:13:13 PM - 12:13:43 PM (8/20/2013) BN 1 - 23

Gregg Drilling & Testing - Case Method & iCAP® Results

PDIPLOT Ver. 2012.2 - Printed: 27-Aug-2013

Test date: 20-Aug-2013

D44 - S-0021R @ 30ft



D44 - S-0021R @ 35ft
OP: MSULLIVAN

140LB AUTO HAMMER
Test date: 20-Aug-2013

AR: 1.45 in^2
LE: 40.58 ft
WS: 16,807.9 f/s

SP: 0.492 k/ft3
EM: 30,000 ksi
JC: 0.35

EFV: Energy of FV
BPM: Blows per Minute
EMX: Max Transferred Energy

VMX: Maximum Velocity
ETR: Energy Transfer Ratio

BL#	depth	EFV	BPM	EMX	VMX	ETR
	ft	k-ft	**	k-ft	f/s	(%)
1	0.00	0.3	0.0	0.3	12.0	82.7
2	0.00	0.3	20.2	0.3	12.4	86.2
3	0.00	0.3	49.5	0.3	12.2	88.0
4	0.00	0.3	49.7	0.3	12.2	88.8
5	0.00	0.3	49.6	0.3	12.0	89.7
6	0.00	0.3	49.8	0.3	12.3	91.1
7	0.00	0.3	49.8	0.3	12.8	89.7
8	0.00	0.3	50.0	0.3	13.2	92.1
9	0.00	0.3	50.1	0.3	12.2	88.5
10	0.00	0.3	50.1	0.3	11.1	86.1
11	0.00	0.3	50.1	0.3	11.5	89.0
12	0.00	0.3	50.1	0.3	13.0	91.3
13	0.00	0.3	50.2	0.3	12.1	88.3
14	0.00	0.3	50.1	0.3	12.2	91.7
15	0.00	0.3	50.1	0.3	12.4	90.2
16	0.00	0.3	50.1	0.3	11.7	90.0
17	0.00	0.3	50.1	0.3	13.0	90.0
18	0.00	0.3	50.2	0.3	11.5	87.4
19	0.00	0.3	50.3	0.3	12.3	87.2
20	0.00	0.3	50.2	0.3	12.9	89.1
21	0.00	0.3	50.1	0.3	12.8	90.1
22	0.00	0.3	50.1	0.3	12.6	87.8
23	0.00	0.3	50.3	0.3	12.8	88.8
24	0.00	0.3	50.3	0.3	12.5	87.8
25	0.00	0.3	50.2	0.3	12.6	88.8
26	0.00	0.3	50.2	0.3	12.8	89.0
27	0.00	0.3	50.5	0.3	12.3	88.3
28	0.00	0.3	50.4	0.3	12.3	86.6
29	0.00	0.3	50.3	0.3	11.5	85.0
30	0.00	0.3	50.3	0.3	11.6	85.8
31	0.00	0.3	50.2	0.3	12.2	88.0
32	0.00	0.3	50.3	0.3	12.6	86.7
33	0.00	0.3	50.4	0.3	11.4	83.5
34	0.00	0.3	50.8	0.3	11.7	83.8
35	0.00	0.3	50.1	0.3	11.5	86.0
36	0.00	0.3	50.5	0.3	12.3	87.9
37	0.00	0.3	50.4	0.3	12.8	87.5
38	0.00	0.3	50.4	0.3	12.8	87.6
39	0.00	0.3	50.3	0.3	12.0	87.2
40	0.00	0.3	50.4	0.3	12.4	86.9
41	0.00	0.3	50.3	0.3	12.1	90.2
42	0.00	0.3	49.9	0.3	12.6	87.6
43	0.00	0.3	50.0	0.3	11.7	82.9
44	0.00	0.3	50.8	0.3	12.5	88.4
	Average	0.3	49.5	0.3	12.3	87.9
	Std. Dev.	0.0	4.5	0.0	0.5	2.2
	Maximum	0.3	50.8	0.3	13.2	92.1
	@ Blow#	8	34	8	8	8

Total number of blows analyzed: 44

Time Summary

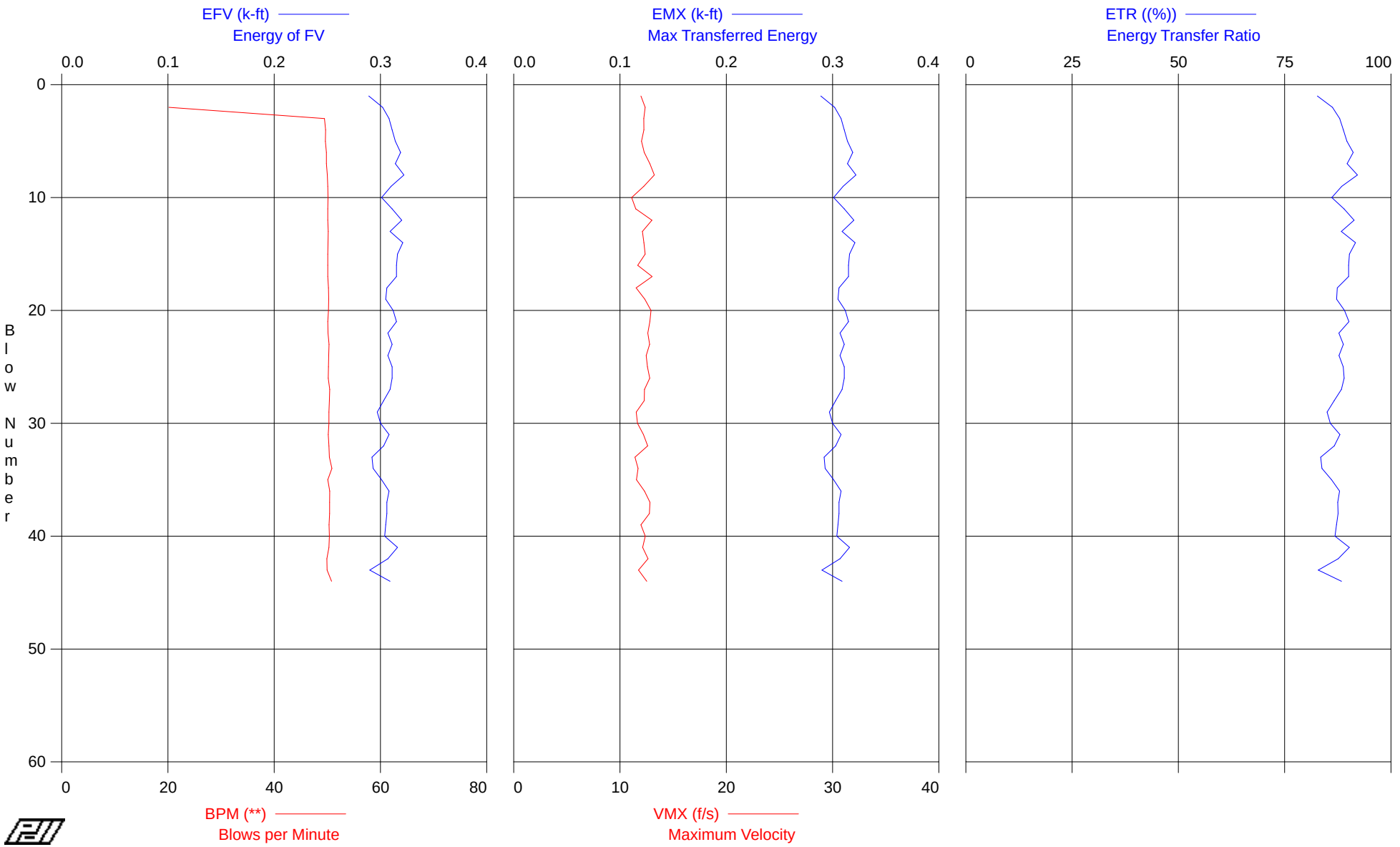
Drive 53 seconds 12:36:12 PM - 12:37:05 PM (8/20/2013) BN 1 - 44

Gregg Drilling & Testing - Case Method & iCAP® Results

PDIPLOT Ver. 2012.2 - Printed: 27-Aug-2013

Test date: 20-Aug-2013

D44 - S-0021R @ 35ft



D44 - S-0021R @ 40ft
OP: MSULLIVAN

140LB AUTO HAMMER
Test date: 20-Aug-2013

AR: 1.45 in^2
LE: 45.75 ft
WS: 16,807.9 f/s

SP: 0.492 k/ft3
EM: 30,000 ksi
JC: 0.35

EFV: Energy of FV
BPM: Blows per Minute
EMX: Max Transferred Energy

VMX: Maximum Velocity
ETR: Energy Transfer Ratio

BL#	depth	EFV	BPM	EMX	VMX	ETR
	ft	k-ft	**	k-ft	f/s	(%)
1	0.00	0.3	0.0	0.3	12.0	80.3
2	0.00	0.3	19.0	0.3	11.6	81.3
3	0.00	0.3	49.3	0.3	11.6	83.4
4	0.00	0.3	49.3	0.3	11.9	88.5
5	0.00	0.3	49.6	0.3	11.8	88.9
6	0.00	0.3	49.8	0.3	12.5	88.1
7	0.00	0.3	49.5	0.3	12.0	86.5
8	0.00	0.3	49.7	0.3	12.0	86.5
9	0.00	0.3	49.6	0.3	11.4	93.5
10	0.00	0.3	49.7	0.3	12.2	87.9
11	0.00	0.3	49.8	0.3	11.9	85.0
12	0.00	0.3	49.6	0.3	11.9	84.3
13	0.00	0.3	49.5	0.3	12.0	83.7
14	0.00	0.3	49.9	0.3	12.2	84.8
15	0.00	0.3	50.2	0.3	12.2	88.1
16	0.00	0.3	50.3	0.3	12.5	87.5
17	0.00	0.3	50.1	0.3	12.2	89.9
18	0.00	0.3	50.2	0.3	12.3	89.1
19	0.00	0.3	49.9	0.3	12.5	88.2
20	0.00	0.3	49.8	0.3	11.5	85.1
21	0.00	0.3	49.8	0.3	12.4	87.3
22	0.00	0.3	49.8	0.3	12.6	87.7
23	0.00	0.3	50.2	0.3	11.8	85.8
24	0.00	0.3	50.0	0.3	12.3	88.4
25	0.00	0.3	50.1	0.3	12.6	85.8
26	0.00	0.3	49.9	0.3	12.1	84.8
27	0.00	0.3	49.8	0.3	12.2	85.0
28	0.00	0.3	49.8	0.3	12.4	82.9
29	0.00	0.3	50.2	0.3	11.6	85.1
30	0.00	0.3	50.5	0.3	12.3	85.9
31	0.00	0.3	50.6	0.3	12.7	85.8
32	0.00	0.3	50.6	0.3	12.6	87.4
33	0.00	0.3	50.1	0.3	12.1	87.6
34	0.00	0.3	49.9	0.3	12.7	86.2
35	0.00	0.3	50.4	0.3	12.8	88.5
36	0.00	0.3	50.2	0.3	12.4	88.5
37	0.00	0.3	50.0	0.3	12.8	86.6
38	0.00	0.3	50.0	0.3	12.7	86.5
39	0.00	0.3	50.4	0.3	12.0	83.7
40	0.00	0.3	50.4	0.3	12.1	84.1
41	0.00	0.3	50.8	0.3	12.3	85.8
42	0.00	0.3	50.7	0.3	13.0	86.8
43	0.00	0.3	50.7	0.3	12.8	89.3
44	0.00	0.3	50.3	0.3	13.0	88.5
45	0.00	0.3	50.1	0.3	13.1	88.3
46	0.00	0.3	50.5	0.3	12.8	88.3
47	0.00	0.3	50.5	0.3	13.7	89.7
48	0.00	0.3	50.6	0.3	13.1	87.7
49	0.00	0.3	50.0	0.3	13.8	87.5
50	0.00	0.3	51.0	0.3	13.6	87.4
51	0.00	0.3	50.3	0.3	13.0	88.4
52	0.00	0.3	50.9	0.3	12.1	87.4
53	0.00	0.3	50.5	0.3	13.4	88.0
54	0.00	0.3	50.6	0.3	12.7	88.4
55	0.00	0.3	50.0	0.3	11.5	83.4
56	0.00	0.3	50.7	0.3	13.4	91.0
57	0.00	0.3	50.9	0.3	12.4	88.8
58	0.00	0.3	50.8	0.3	11.3	86.7
60	0.00	0.3	41.7	0.3	11.8	88.5
	Average	0.3	49.5	0.3	12.4	86.9
	Std. Dev.	0.0	4.2	0.0	0.6	2.3
	Maximum	0.3	51.0	0.3	13.8	93.5
	@ Blow#	9	50	9	49	9

Total number of blows analyzed: 59

Time Summary

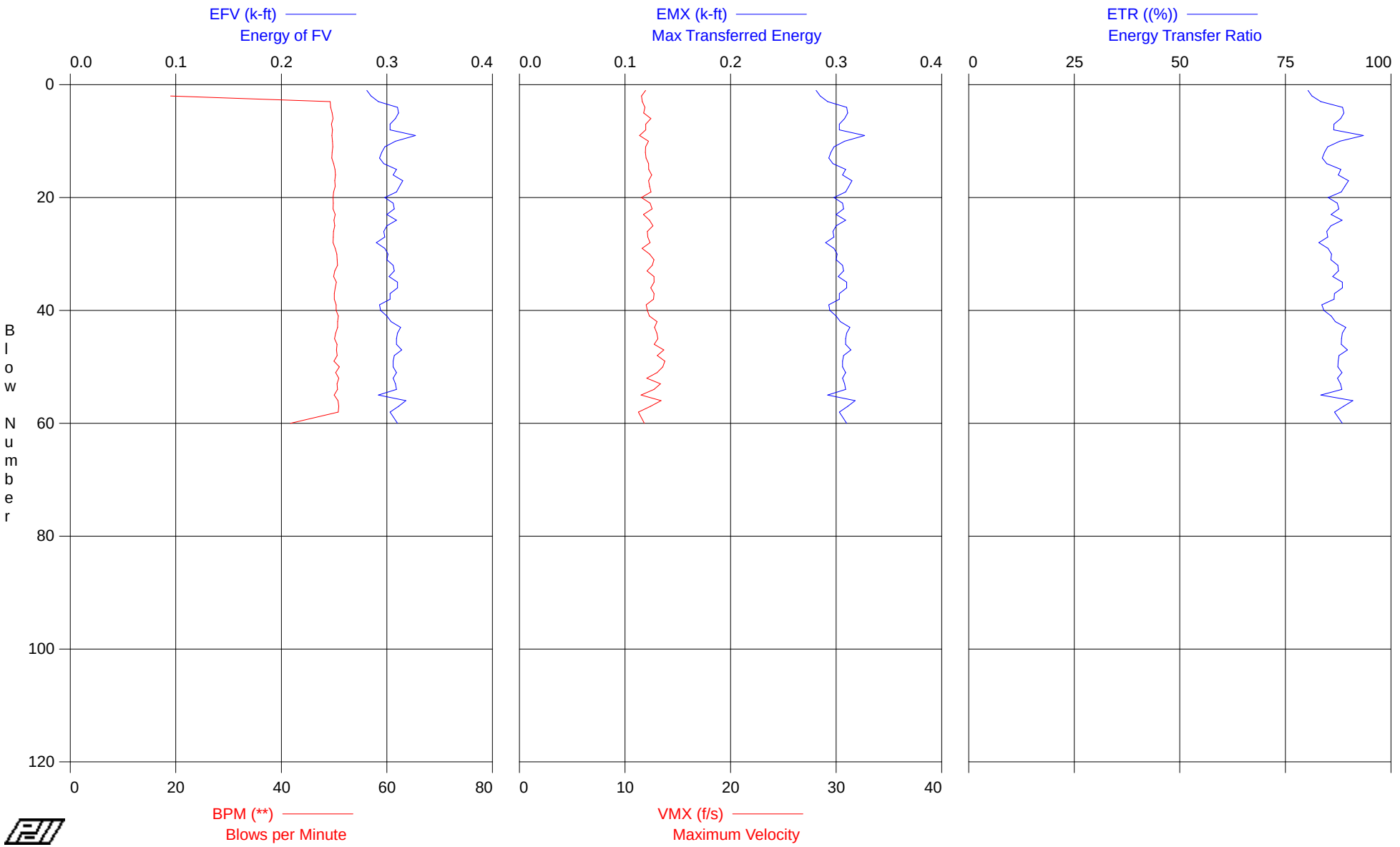
Drive 1 minute 13 seconds 12:49:29 PM - 12:50:42 PM (8/20/2013) BN 1 - 60

Gregg Drilling & Testing - Case Method & iCAP® Results

PDIPLOT Ver. 2012.2 - Printed: 27-Aug-2013

Test date: 20-Aug-2013

D44 - S-0021R @ 40ft



D44 - S-0021R @ 45ft
OP: MSULLIVAN

140LB AUTO HAMMER
Test date: 20-Aug-2013

AR: 1.45 in^2
LE: 50.58 ft
WS: 16,807.9 f/s

SP: 0.492 k/ft3
EM: 30,000 ksi
JC: 0.35

EFV: Energy of FV
BPM: Blows per Minute
EMX: Max Transferred Energy

VMX: Maximum Velocity
ETR: Energy Transfer Ratio

BL#	depth	EFV	BPM	EMX	VMX	ETR
	ft	k-ft	**	k-ft	f/s	(%)
1	0.00	0.3	0.0	0.3	10.9	75.4
2	0.00	0.3	19.8	0.3	11.5	82.9
3	0.00	0.3	49.4	0.3	11.6	80.0
4	0.00	0.3	49.3	0.3	11.2	81.6
5	0.00	0.3	49.7	0.3	12.8	86.4
6	0.00	0.3	49.7	0.3	11.7	83.6
7	0.00	0.3	49.9	0.3	12.2	87.1
8	0.00	0.3	50.0	0.3	12.1	84.8
9	0.00	0.3	49.8	0.3	12.3	85.3
10	0.00	0.3	49.6	0.3	12.5	86.1
11	0.00	0.3	49.6	0.3	13.0	91.2
12	0.00	0.3	49.7	0.3	12.8	85.8
13	0.00	0.3	50.2	0.3	12.6	86.7
14	0.00	0.3	50.0	0.3	12.8	89.7
15	0.00	0.3	49.6	0.3	13.3	87.6
16	0.00	0.3	49.5	0.3	12.5	84.1
17	0.00	0.3	50.0	0.3	12.8	87.0
18	0.00	0.3	50.3	0.3	12.6	84.3
19	0.00	0.3	50.3	0.3	13.1	88.2
20	0.00	0.3	50.4	0.3	11.9	83.3
21	0.00	0.3	50.5	0.3	12.0	89.6
22	0.00	0.3	50.5	0.3	12.8	86.1
23	0.00	0.3	50.3	0.3	12.4	88.0
24	0.00	0.3	50.4	0.3	12.7	85.9
25	0.00	0.3	50.3	0.3	12.8	90.4
26	0.00	0.3	50.7	0.3	13.9	88.4
27	0.00	0.3	50.5	0.3	12.9	89.2
28	0.00	0.3	50.3	0.3	13.2	85.2
29	0.00	0.3	50.5	0.3	12.6	86.8
30	0.00	0.3	50.7	0.3	13.5	87.0
31	0.00	0.3	50.3	0.3	12.8	87.7
32	0.00	0.3	50.6	0.3	11.7	85.7
33	0.00	0.3	50.9	0.3	12.9	88.6
34	0.00	0.3	50.7	0.3	12.8	89.3
35	0.00	0.3	51.0	0.3	12.7	90.0
36	0.00	0.3	50.2	0.3	12.4	88.3
37	0.00	0.3	50.1	0.3	12.2	88.4
38	0.00	0.3	50.8	0.3	11.6	88.7
39	0.00	0.3	51.0	0.3	13.2	92.2
40	0.00	0.3	50.6	0.3	12.4	86.4
41	0.00	0.3	50.0	0.3	13.3	86.6
42	0.00	0.3	50.3	0.3	13.1	89.8
43	0.00	0.3	50.3	0.3	13.0	88.5
44	0.00	0.3	50.4	0.3	13.2	89.2
45	0.00	0.3	50.5	0.3	13.3	86.8
46	0.00	0.3	50.5	0.3	13.0	87.2
47	0.00	0.3	50.3	0.3	12.4	84.0
48	0.00	0.3	50.6	0.3	12.7	87.2
49	0.00	0.3	50.6	0.3	11.8	81.5
50	0.00	0.3	50.5	0.3	12.2	81.3
51	0.00	0.3	51.1	0.3	11.9	82.1
52	0.00	0.3	50.8	0.3	11.9	83.0
53	0.00	0.3	50.6	0.3	11.2	82.2
54	0.00	0.3	50.5	0.3	11.7	83.7
55	0.00	0.3	50.4	0.3	11.8	84.0
56	0.00	0.3	50.5	0.3	11.7	84.7
57	0.00	0.3	50.3	0.3	11.9	84.1
58	0.00	0.3	50.4	0.3	12.3	85.1
59	0.00	0.3	50.6	0.3	12.3	84.6
60	0.00	0.3	50.5	0.3	12.2	85.9
61	0.00	0.3	50.5	0.3	12.6	86.3
62	0.00	0.3	52.7	0.3	11.3	74.7
63	0.00	0.3	46.1	0.3	11.3	81.4
64	0.00	0.3	50.6	0.3	11.4	81.6
65	0.00	0.3	50.6	0.3	11.4	82.1
66	0.00	0.3	50.6	0.3	11.8	83.8
67	0.00	0.3	50.5	0.3	11.6	82.6

D44 - S-0021R @ 45ft
OP: MSULLIVAN
140LB AUTO HAMMER
Test date: 20-Aug-2013

BL#	depth	EFV	BPM	EMX	VMX	ETR
	ft	k-ft	**	k-ft	f/s	(%)
68	0.00	0.3	50.5	0.3	11.6	84.0
69	0.00	0.3	50.2	0.3	12.1	83.9
70	0.00	0.3	50.4	0.3	12.5	84.5
71	0.00	0.3	50.4	0.3	11.8	84.6
72	0.00	0.3	50.5	0.3	12.0	85.1
73	0.00	0.3	50.1	0.3	12.6	84.8
74	0.00	0.3	51.0	0.3	11.6	83.0
75	0.00	0.3	48.9	0.3	11.4	86.5
76	0.00	0.3	49.1	0.3	11.9	85.2
77	0.00	0.3	49.3	0.3	12.3	85.3
78	0.00	0.3	50.0	0.3	11.6	83.4
79	0.00	0.3	49.8	0.3	11.6	82.1
80	0.00	0.3	50.2	0.3	11.9	83.3
81	0.00	0.3	49.8	0.3	11.6	82.6
82	0.00	0.3	50.0	0.3	12.5	82.7
83	0.00	0.3	49.8	0.3	11.4	81.4
84	0.00	0.3	50.1	0.3	12.0	82.6
85	0.00	0.3	50.0	0.3	11.4	82.4
86	0.00	0.3	50.6	0.3	11.7	80.9
87	0.00	0.3	50.5	0.3	11.6	80.7
88	0.00	0.3	50.4	0.3	12.3	80.7
89	0.00	0.3	50.2	0.3	12.6	79.9
90	0.00	0.3	50.0	0.3	12.7	81.7
91	0.00	0.3	50.9	0.3	12.9	85.3
92	0.00	0.3	50.5	0.3	13.7	86.7
93	0.00	0.3	50.9	0.3	13.0	77.3
94	0.00	0.3	50.6	0.3	13.1	82.7
95	0.00	0.3	50.9	0.3	13.0	80.9
96	0.00	0.3	50.5	0.3	13.0	82.4
97	0.00	0.3	50.8	0.3	12.8	82.0
98	0.00	0.3	50.5	0.3	13.1	82.7
99	0.00	0.3	50.3	0.3	13.2	82.3
100	0.00	0.3	50.5	0.3	13.0	82.7
101	0.00	0.3	50.4	0.3	12.6	84.1
102	0.00	0.3	50.5	0.3	13.5	84.0
103	0.00	0.3	50.5	0.3	12.8	84.7
	Average	0.3	50.0	0.3	12.3	84.7
	Std. Dev.	0.0	3.1	0.0	0.7	3.1
	Maximum	0.3	52.7	0.3	13.9	92.2
	@ Blow#	39	62	39	26	39

Total number of blows analyzed: 103

Time Summary

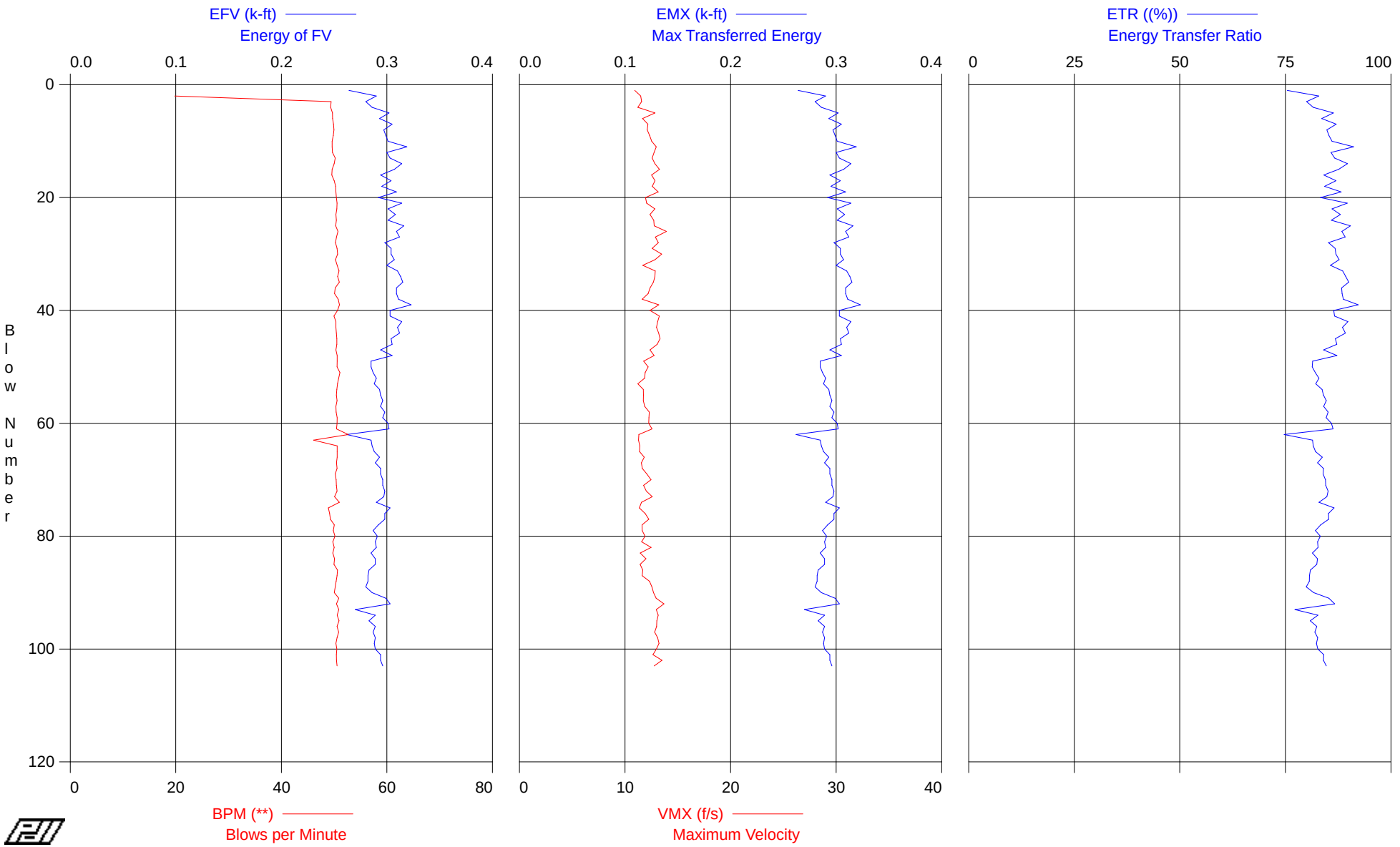
Drive 2 minutes 4 seconds 1:04:05 PM - 1:06:09 PM (8/20/2013) BN 1 - 103

Gregg Drilling & Testing - Case Method & iCAP® Results

PDIPLOT Ver. 2012.2 - Printed: 27-Aug-2013

Test date: 20-Aug-2013

D44 - S-0021R @ 45ft



D44 - S-0021R @ 50ft
OP: MSULLIVAN

140LB AUTO HAMMER
Test date: 20-Aug-2013

AR: 1.45 in^2
LE: 55.75 ft
WS: 16,807.9 f/s

SP: 0.492 k/ft3
EM: 30,000 ksi
JC: 0.35

EFV: Energy of FV
BPM: Blows per Minute
EMX: Max Transferred Energy

VMX: Maximum Velocity
ETR: Energy Transfer Ratio

BL#	depth	EFV	BPM	EMX	VMX	ETR
	ft	k-ft	**	k-ft	f/s	(%)
2	0.00	0.3	0.0	0.3	11.3	77.6
3	0.00	0.3	19.2	0.3	10.9	80.5
4	0.00	0.3	49.1	0.3	11.7	83.6
5	0.00	0.3	49.7	0.3	12.9	86.1
6	0.00	0.3	49.9	0.3	13.0	85.3
7	0.00	0.3	49.6	0.3	12.1	82.3
8	0.00	0.3	49.5	0.3	13.1	83.7
9	0.00	0.3	49.3	0.3	13.0	83.9
10	0.00	0.3	49.5	0.3	13.0	84.0
11	0.00	0.3	49.7	0.3	11.6	80.3
12	0.00	0.3	49.6	0.3	11.9	80.1
13	0.00	0.3	49.9	0.3	12.2	82.6
14	0.00	0.3	49.7	0.3	11.8	82.2
15	0.00	0.3	50.1	0.3	12.2	81.0
16	0.00	0.3	50.0	0.3	12.3	80.4
17	0.00	0.3	50.0	0.3	12.4	81.1
18	0.00	0.3	49.7	0.3	11.6	79.6
19	0.00	0.3	49.9	0.3	11.6	77.5
20	0.00	0.3	50.2	0.3	11.4	80.7
21	0.00	0.3	50.5	0.3	11.6	80.9
22	0.00	0.3	50.5	0.3	12.5	82.3
23	0.00	0.3	50.6	0.3	12.5	84.4
24	0.00	0.3	49.9	0.3	12.1	81.6
25	0.00	0.3	50.6	0.3	12.8	82.8
26	0.00	0.3	50.3	0.3	12.4	82.6
27	0.00	0.3	50.2	0.3	12.2	81.2
28	0.00	0.3	50.1	0.3	12.6	83.0
29	0.00	0.3	50.5	0.3	12.5	83.3
30	0.00	0.3	50.0	0.3	13.0	84.0
31	0.00	0.3	50.1	0.3	12.9	82.0
32	0.00	0.3	50.2	0.3	12.1	81.6
33	0.00	0.3	50.9	0.3	12.3	84.1
34	0.00	0.3	50.9	0.3	12.8	85.4
35	0.00	0.3	51.0	0.3	13.0	84.4
36	0.00	0.3	50.3	0.3	13.3	86.1
37	0.00	0.3	50.1	0.3	12.9	87.1
38	0.00	0.3	50.8	0.3	12.8	87.1
39	0.00	0.3	50.5	0.3	12.1	84.8
40	0.00	0.3	49.8	0.3	12.4	84.0
41	0.00	0.3	50.9	0.3	12.6	86.0
42	0.00	0.3	51.0	0.3	13.3	87.3
43	0.00	0.3	51.0	0.3	13.3	87.8
44	0.00	0.3	50.8	0.3	13.0	85.1
45	0.00	0.3	50.8	0.3	13.5	85.4
46	0.00	0.3	51.0	0.3	13.3	84.9
47	0.00	0.3	50.8	0.3	13.4	85.3
48	0.00	0.3	50.9	0.3	12.5	86.8
49	0.00	0.3	50.6	0.3	12.5	83.0
50	0.00	0.3	50.7	0.3	12.9	84.5
51	0.00	0.3	50.4	0.3	11.3	79.1
52	0.00	0.3	50.3	0.3	12.4	80.7
56	0.00	0.3	35.1	0.3	12.1	80.5
58	0.00	0.3	38.5	0.3	12.5	80.8
61	0.00	0.3	49.2	0.3	12.8	82.8
64	0.00	0.3	33.7	0.3	13.1	84.5
66	0.00	0.3	41.2	0.3	12.1	85.8
67	0.00	0.3	51.0	0.3	11.5	84.6
70	0.00	0.3	35.8	0.3	12.9	84.9
71	0.00	0.3	49.5	0.3	12.4	83.6
72	0.00	0.3	51.7	0.3	13.2	86.2
73	0.00	0.3	50.6	0.3	12.5	83.2
74	0.00	0.3	51.1	0.3	13.2	85.8
75	0.00	0.3	50.6	0.3	12.7	82.8
76	0.00	0.3	50.5	0.3	12.0	79.1
77	0.00	0.3	50.4	0.3	12.5	81.7
78	0.00	0.3	51.1	0.3	12.2	83.3
79	0.00	0.3	51.2	0.3	13.2	83.9

D44 - S-0021R @ 50ft
OP: MSULLIVAN

140LB AUTO HAMMER
Test date: 20-Aug-2013

BL#	depth	EFV	BPM	EMX	VMX	ETR
	ft	k-ft	**	k-ft	f/s	(%)
80	0.00	0.3	51.2	0.3	13.5	84.1
81	0.00	0.3	51.2	0.3	13.0	84.4
82	0.00	0.3	51.3	0.3	13.4	86.3
	Average	0.3	48.9	0.3	12.5	83.3
	Std. Dev.	0.0	5.1	0.0	0.6	2.3
	Maximum	0.3	51.7	0.3	13.5	87.8
	@ Blow#	43	72	43	45	43

Total number of blows analyzed: 70

Time Summary

Drive	1 minute 37 seconds	1:20:37 PM - 1:22:14 PM (8/20/2013) BN 2 - 82

Gregg Drilling & Testing - Case Method & iCAP® Results

PDIPLOT Ver. 2012.2 - Printed: 27-Aug-2013

Test date: 20-Aug-2013

D44 - S-0021R @ 50ft